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ERROR ESTIMATION OF LINEAR ARRAY RADIATION PATTERN DUE TO LAYOUT TOLERANCE AND FAULTY OPERATION

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ABSTRACT

The radiation pattern of a linear array is investigated for different conditions of layout tolerance and faulty operation using the moment method. It is found that although layout may not noticeably affect the directivity, the side lobe levels can enhance appreciably. Tables will illustrate the changes in the radiation pattern characteristics due to a number of faulty operational conditions which involve loss of some elements' excitation or elevation position. Present investigation will increase the understanding of damage control of radar operation employing such an array and supply fruitful data for performance of high frequency ground-wave ship/rig mounted radar as well as portable radar.

1. Introduction

The receiving antenna of a ground wave radars in the area of ocean remote sensing is usually a linear array to achieve a highly directional narrow beam in the azimuthal direction. The array elements which can be in the form of quarter-wave length monopole whips over a ground plane, should be equally spaced, along a straight line and at the same elevation. However, layout tolerance and land topography could lead to conditions where the elements are not exactly equally spaced, not along a straight line and/or not at the same elevation (staggered). The effects of these layout errors-if they occur individually or combined, on the radiation pattern is to be evaluated using the moment method.

Disconnection of the feeding cables to some of the array elements and loss of their vertical positions are some of the conditions that may arise due to coastal areas' possible severe meteorological conditions and can lead to a malfunction to the operation of the array. Also, the moment method will be used to investigate numerically the changes in the far field radiation pattern under different damage conditions of the array elements.

Array description and methodology

The linear array is formed of six quarter-wavelength monopole whips with half wavelength separation over a perfect ground plane and of 0.005λ diameter. The array is long the y axis with broadside direction along the x axis as shown in Fig. 1. The Numerical Electromagnetics Code (NEC) [1], which is based on the moment method is used to calculate the far field radiation pattern of the linear Two main investigations of the radiation pattern will be carried out on the linear array for various conditions of

i) layout tolerance,

Variations in the coordinates of each array element is randomly set such that $|\Delta x|/\lambda$, $|\Delta y|/\lambda$, and $|\Delta z|/\lambda \leq \delta$.

ii) elements' damage

The investigation will consider four cases of a damaged array element, a) excitation cable to the element is disconnected (element becomes parasite), b) element suspension gives way and the element falls down while excitation cable is connected (excited horizontal

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element) or c) unconnected (parasite horizontal element) or finally, d) the element becomes missing. The choice of the elements with the above either one on these damages will be random.

3. Discussion of numerical results

Figure 2 shows a linear plot of the far field radiation patterns for the six element linear phased array in three cases of layout tolerance factor $\delta = 0$, 0.1, and0.2, where it is observed that as the location tolerance error increases, the sidelobe levels considerably increase. The reduction in directivity occurs at larger values of δ. Among the three space coordinates, it is found that the tolerance error in the x-direction (broadside) direction has the dominant effect on the radiation pattern.

The radiation patterns for a number of cases of damaged elements have been calculated and are illustrated in table. 1. For the cases shown in the table, although the directivity does not appreciably deteriorate, the sidelobe levels considerably increase. Also, it is observed that half power beam width change with up to 35% in some cases of damaged elements.

4. Conclusion

A numerical study has been carried out for the variations of far field radiation pattern of a linear phased monopole array over a perfect ground under error conditions resulting from either geometrical layout tolerance or damage to some of the array elements. It is demonstrated that usually, the sidelobe levels are the radiation pattern parameters that are the most sensitive to either one of the error conditions. This may lead to considerable reduction in the radar system capability in identifying different sized targets.

References

1. G. J. Burke and A. J. Poggio, " Numerical Electromagnetics Code (NEC)- Method of Moments," Parts I and II, Technical Document 116, Naval Ocean Systems Center, San Diego, California, Revised January 1980.

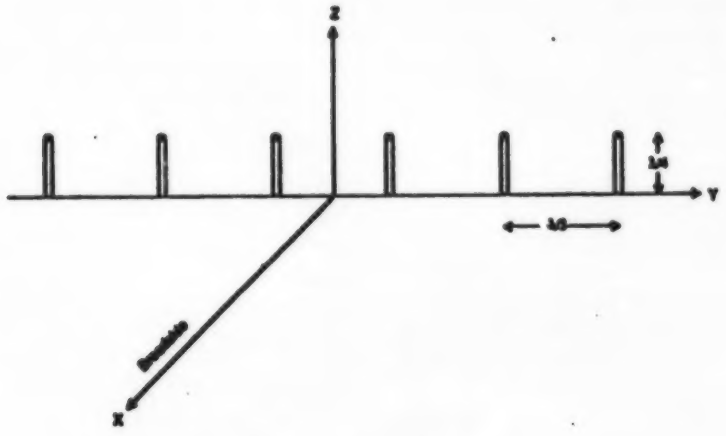

Fig. 1 Six Element Linear Monopole Array

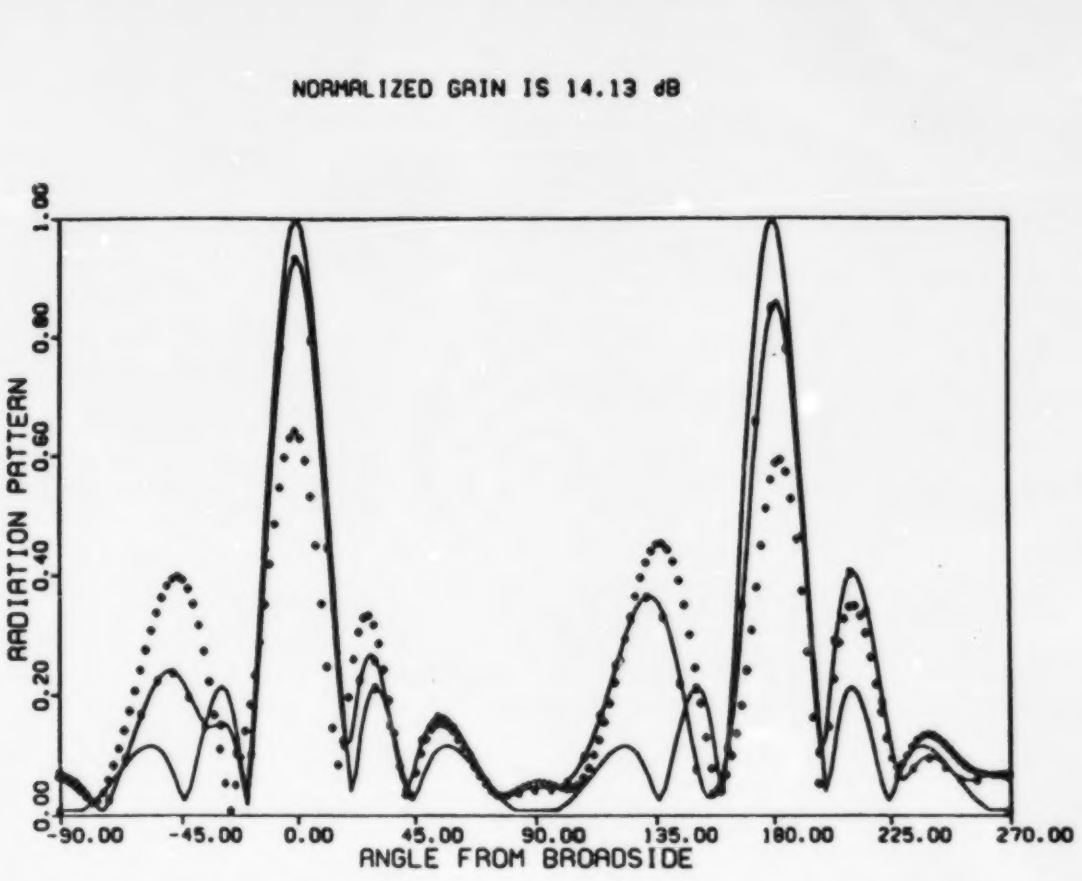

FIG. 2. Far field H-plane patterns for a linear array with exact layout(——), and layout tolerance of $\lambda/10$ (-■-) and $\lambda/5$ (● ● ●).

Table 1. Radiation pattern Characteristics for a six-element phased array at different damage cases to its elements

case	H-plane directivity	H-plane half power beam width	side lobes angle	level
normal operation	14.13dB	9°	30°	-13.37
Elm. 3 not excited	13.62dB	8.5°	28° -30°	-8.05dB -7.99dB
Elm. 2 & 3 not excited	12.62dB	8.5°	25° -28°	-6.18dB -6.55dB
Elm. 3 flat at 0.2λ and excited	13.00dB	8°	28° -30°	-5.7dB -6.25dB
Elm. 3 not present	13.00dB	8°	28° -30°	-5.70dB -6.25dB